The Greater Strength
of
Southern Yellow Pine

A MONOGRAPH

In which is discussed the stresses
to which structural timbers may
be subjected, and including recom-
mendations for the correct use of
Southern Yellow Pine

Southern Pine Association
NEW ORLEANS LOUISIANA

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Pure Stands of Southern Pine Produce Structural LUMBER of Uniform Strength and Grade.

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The Strongest Structural Lumber for General Construction Purposes

STRUCTURAL LUMBER produced from the Southern Pines has always been accepted as the strongest structural lumber available in commercial quantities for general construction purposes.

The inherent characteristics of Southern Yellow Pine, its great density and specific dry weight, its straight grain and large resin content, its comparative freedom from serious defects, permits the production of uniform grades of structural material to which the highest stress values may be safely assigned. Actual performance over a long period of years supported by comparative tests of material selected at random from local lumber stocks prove conclusively that Southern Yellow Pine is the most durable and the strongest structural lumber easily purchased in the market.

Specifiers of lumber will find economy in specifying Southern Yellow Pine because of the higher stress value that may be applied with safety and the assurance that the grade specified will in fact be delivered. Something "just as good" at a lower price is a substitution that experienced designers will not permit.

For further information regarding Southern
Yellow Pine or Lumber Construction address

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The Greater Strength of Southern Yellow Pine

Factors Which Affect Strength of Timbers

THE MOST important factors which influence the strength of structural timbers are the density (or dry weight), the moisture content, and the size, number and location of defects. These factors must all be considered in design and grading if the maximum utilization is to be obtained from the material used.

Effect of Defects on Strength

THE ALLOWABLE working stress for any grade of timber must take into consideration the loss of strength which results from the defects permitted in the grade. Thus, when a knot of a diameter equal to one-fourth the width of the face on which it occurs, is allowed at the point of maximum stress, the timber is assumed to be only three-fourths as strong as one of clear material of the same quality. The number of defects is controlled by specifying the total sum allowable in terms of the dimensions of the beam. This provision also controls the quality of the material to some extent, since timbers with a large number of knots are usually from the tops of trees and are inherently weaker than those from the lower or butt cuts.

Expert Grading Encourages Economy in Design

A SINGLE commercial grade of timber often includes material that varies greatly in strength. For such a commercial grade, design must be based on the weak timbers, and the full strength of the better timbers cannot be utilized. For example, inspection of a warehouse revealed that the single commercial grade used contained timbers of sufficiently wide range in quality to represent three or four grades if graded for strength.

APPROXIMATELY two-thirds of the timbers would have qualified, in re-grading, as a Select grade. If the building had been re-designed on the basis of the higher working stresses permissible with the Select grade, the other third of the timbers of lower grade would have been unnecessary, and the re-designed building could have been safely depended upon to carry as great a load as the construction actually used. The strength of the warehouse, therefore, was dependent on the weak one-third of the timbers, which were scattered promiscuously throughout the structure. This actual case illustrates the possible saving in floor space and construction costs which may be made by using material in accordance with its known strength.

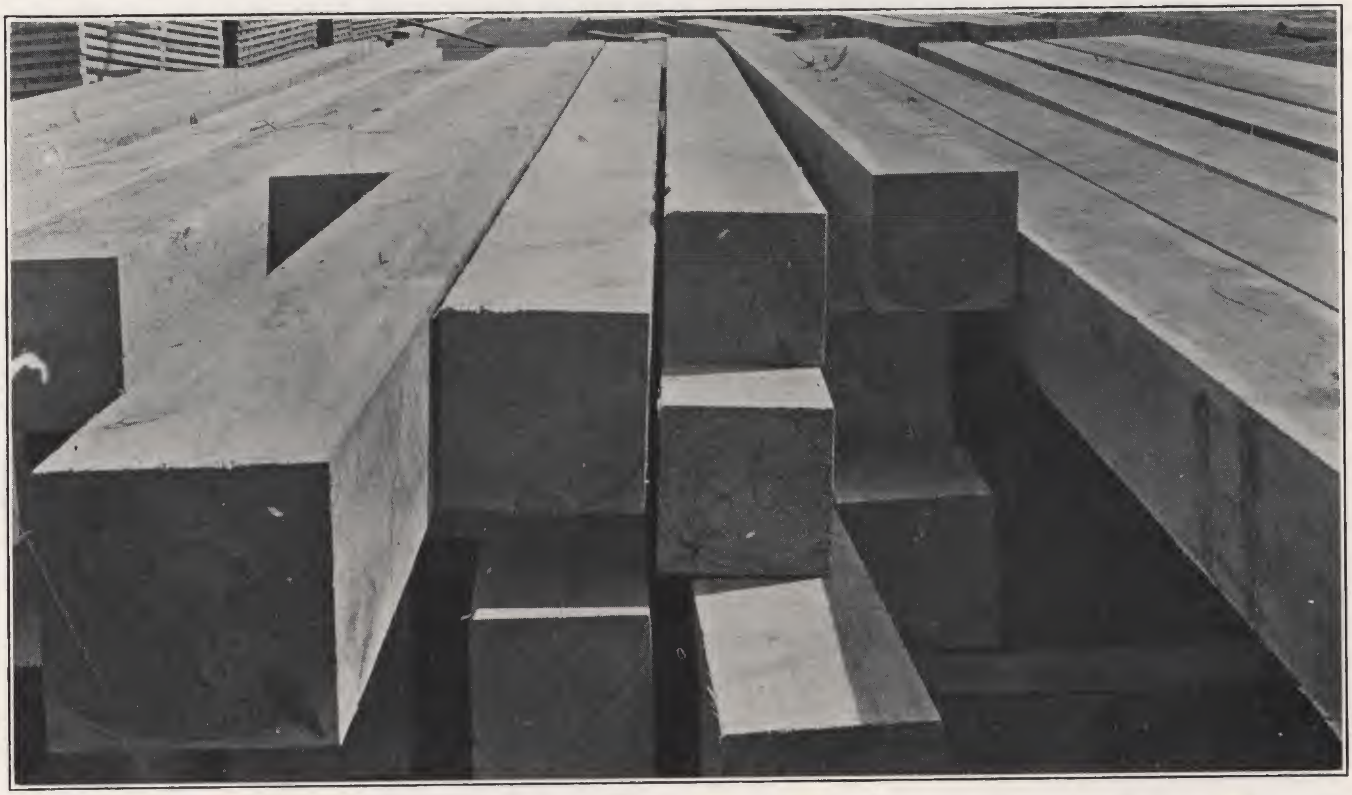
Grading of Structural Timbers for Working Stresses

SAFE WORKING stresses to be used in design with any building material should be based on the general character and quality of that material available for use in the open market. The characteristic growth of the trees of any species determines the manner, arrangement and amount of defects which are most likely to prevail. If specific defects such as irregular grain or shake or check predominate in a species, it might be expected that such defects would be and they are prevalent in the commercial run of timber manufactured from that species. It is not practical for either manufacturer or designer to apply the necessarily detailed rules required to segregate a series of strength grades which, in the interest of simplification and standardization, it is intended should result in comparative strength values for all species of wood.

ACCURACY and economy in design can best be secured by specifying the species of lumber, which, because of inherent characteristics, produces the most uniform and strongest structural material.

Southern Yellow Pine the Strongest Species of Lumber That Is Commercially Available

THE PHYSICAL properties of the Southern Yellow Pines are so scientifically adjusted by nature that Southern Yellow Pine is used for structural purposes to a greater extent than all other species. It is a natural law, correspondent to the coniferous woods, that the strength varies with the specific dry weight and density.



Southern Pine Timbers.—Uniform Grades of Southern Pine Permit the Highest Stress Values to Be Used With Safety.

IT IS the quality of great density and specific dry weight that makes Southern Yellow Pine the strongest of the structural woods commonly used.

"TRUE Longleaf Pine averages heavier, stronger and tougher than Douglas Fir", reads a technical note published by the Forest Products Laboratory of the United States Forest Service, and continues: "True Shortleaf averages heavier and tougher than Fir, but is about equal to it in strength as a beam or post. Loblolly Pine, though averaging heavier than Fir, is somewhat weaker. The difference in strength between any of these pines and Douglas Fir, however, is not so great but that low density pieces of one species are weaker than the average for the other species.

"THE ROCKY Mountain type of Douglas Fir averages considerably weaker than the Pacific Coast type."

FOR MANY years Southern Yellow Pine has been divided commercially into two classes—dense material called longleaf, and material of generally lower density called shortleaf pine. Coarse grained, light-weight material, though actually longleaf, has been accepted only as shortleaf. The confidence with which architects and engineers have always specified Southern Yellow

Pine grades has influenced other manufacturers to use Southern Yellow Pine as a standard of comparison for both strength and general utility.

New York Building Code Tests Prove Southern Yellow Pine Most Uniform and Strongest

IN 1921 a meeting was called to consider the question of asking a revision of values of working stresses in the New York Building Code. The discussion on the subject disclosed that there existed no confirmation of the results obtained by the Forest Products Laboratories at Madison, Wisconsin, in their application to the character and type of material commercially available in the New York market.

A COMMITTEE consisting of nine members, five of whom were representatives of the Bureaus of Building of the five New York Boroughs, selected representative material for test at the Columbia University Testing Laboratories.

THESE TESTS proved conclusively that Southern Yellow Pine was the strongest and most uniform material found in the New York market. It is the assurance with which they may design in Southern Yellow Pine, knowing that the material delivered out of local stocks will measure up to the stress values they have assigned to it, that makes architects and engineers willing to pay more per thousand feet for Southern Yellow Pine. The experienced designer permits no substitution.

A resume of the results of the Columbia University Tests is given herewith:

MINOR'S (small)

	Elastic Limit			Modulus of Rupture		
	Aver.	Max.	Min.	Aver.	Max.	Min.
N. Y. Firs	5130	7380	1525	8925	12300	4730
N. Y. L. L. Pines	5460	7950	3390	9585	12820	6580
N. Y. S. L. Pines	4720	7100	3160	8140	9230	6840

MAJORS (Structural size)

	Elastic Limit			Modulus of Rupture		
	Aver.	Max.	Min.	Aver.	Max.	Min.
N. Y. Firs, No. 1 Com.	4305	6775	2520	6125	9655	3970
N. Y. L. L. Pines 1905 Merchant.	4440	6360	2855	6940	9110	4810
N. Y. S. L. Pines 1910 Spec.	3895	4900	2480	5870	7520	4320

The values for modulus of rupture and the corresponding elastic limits occurring in the lower range of test specimens are as follows:

	Elastic Limit			Modulus of Rupture		
	Aver.	Max.	Min.	Aver.	Max.	Min.
New York Longleaf	4105	5370	2855	6040	6710	4810
New York Shortleaf	3680	4890	2480	5485	6430	4320
Coast Type Douglas Fir, No. 1 Com.	3595	4940	2520	4930	6660	3970

On this basis the following values for safe extreme fibre stress can be determined for ordinary use material:

		Factors of Safety on		
	Lbs. Sq. In.	Aver. E. L.	Min. E. L.	Aver. Mod. Rupt.
New York Longleaf (1905 Merchantable)	1600	2.6	1.8	3.8
Coast Type Douglas Fir No. 1 Com.	1350	2.7	1.9	3.7

Forest Products Laboratory Comparisons

CONSIDERABLE information has been published by the United States Forest Products Laboratory showing the relation between the strength of Southern Yellow Pine and its specific gravity. Based on all available tests, formulae have been derived showing this relation in reference to bending strength or modulus of rupture for both pine and fir. In addition, these strengths have all been plotted on one chart, each point representing an average in most cases of about sixty specimens from five different trees in the one locality. These values were obtained on small, clear, straight-grained pieces. The following tabulation of these values is for purposes of comparison:

MODULUS OF RUPTURE Lbs. Sq. In.

	Aver. Chart Value.	Forest Prod. Lab. Formulae.
Douglas Fir (Wyoming, Washington)	7566	7400
Douglas Fir (Washington, Oregon)	8175	7770
Longleaf Pine (Mississippi, Louisiana, Florida)	8475	8370
Longleaf Pine (Louisiana, Florida)	8716	8550
Shortleaf Pine (Arkansas)	7700	6930
Loblolly Pine (Florida)	7600	7360

Southern Pine Sawmill and Log Pond.—It Is Estimated That the Annual Production of Southern Pine Never Will Be Below Six or Seven Billion Feet.

ONE OTHER recent publication of the Forest Products Laboratory, Technical Note Number 147, issued June 15, 1921, in a comparison of the strength of woods used in automobile construction expressed in the per cent of strength of Forest Grown White Ash (100%), gives the comparative values shown in the following table:

Conifers	Strength as Beam or Post	Stiffness	Shock Resistability	Hardness
Fir, Douglas (Pac. Coast)	95.7	122.1	59.9	58.3
Pine, Longleaf	112.2	122.1	77.7	74.8
Pine, Loblolly	93.7	105.6	71.0	60.0
Pine, Shortleaf	94.1	100.6	69.7	64.0

Southern Yellow Pine Grading Rules Insure Grades of Uniform Strength

SOUTHERN YELLOW PINE structural grading rules are built on recognized engineering principles established by tests covering a long period of years, and are based largely on the investigations and recommendations of the Forest Service. They take into account all of the known factors that influence the strength of timber and include only such variations as are necessary to be consistent with the economical production of the wide range of material manufactured in the modern sawmill. When it is considered that a difference in wood character alone may mean a variation of fifty per cent in strength values in two timbers of the same size, it becomes obvious that grading based on a scientific knowledge of wood character is essential to the production of timbers of uniform strength.

EXPERT GRADING is of extreme importance to consumers in bringing about the uniformity of grades, and to prevent including either above-grade or below-grade material in shipments. Architects and engineers can easily obtain grades of timber of known strength without the necessity of going into long technical details in specifications, by specifying the standard grades of Southern Yellow Pine.

Southern Pine Association Structural Grades

THE SOUTHERN PINE ASSOCIATION provides structural timber, heavy joist, and dimension grades adapted to all construction uses.

(1) Select structural grade for heavy construction use in important engineering structures such as main stringers, girders and truss members in bridges and mill buildings.

(2) General structural grades for all ordinary structural uses in buildings, trestles, wharves, piers and general construction, as follows:

(a) No. 1 Common, for use on the interior of buildings where not subject to humidity and not exposed to view or where appearance is not a deciding factor and in temporary false work.

(b) Square Edge and Sound, for exterior and interior use where appearance or use requires full sections with square corners and where the timber is highly subject to decay requiring treatment with a chemical preservative.

(c) Merchantable, for structural uses, either interior or exterior, where appearance and strength are factors and where a guaranty of durability is a requisite when used untreated.

(3) In addition to the timber grades, heavy joist and dimension grades are furnished as follows:

(a) No. 1 Common for ordinary general use where members are framed to form a composite unit as in joisted floor construction, usually covered with sheathing, flooring or ceiling on top and bottom.

(b) No. 2 Common for light load, short span work to be used similarly to the above, where deflection rather than strength is the controlling factor.

(c) No. 3 Common for a less expensive building material commonly employed for studs and very light joists, usable by wasting 25 per cent of the length of at least one-third of the number of pieces of each item in a shipment.

Recommended Working Stresses

[Structural Timber]

IN TIMBER construction, warning of incipient failure occurs long before actual failure. When the design loads include allowance for impact, the recommended working stresses can very properly be increased in direct proportion to the provision for impact. Four classes of use are recognized in the following tabulations in each grade of material:

Class (A) for use in exterior structures or members exposed to saturated moisture conditions such as wharves, piling and sills.

Class (B) for use in exterior structures exposed to the weather but not in contact with the soil, such as bridges and open sheds.

Class (C) for use in interior dry structures such as enclosed buildings, roofs, and roof trusses.

Class (D) for use in temporary false work either interior or exterior.

Recommended Fibre Stresses

(Lbs. per sq. in.)

TABLE I

SELECT STRUCTURAL GRADE, DENSE*

	CLASS A	CLASS B	CLASS C	CLASS D
Bending, extreme fibre	1200	1500	1800	—
Direct tension (net area)	1200	1500	1800	—
Compression (short columns)	1000	1200	1350	—
Compression (long columns)	Reduce direct compression by product of C/75x1/d.***			
Compression (flatwise)	250	300	350	—
Longitudinal shear (uniform load)	100	125	150	—
Longitudinal shear (concentrations)**	150	175	200	—
Shear with grain (details)	150	150	150	—
Design Weight per cubic foot	48 Lbs.	48 Lbs.	42 Lbs	
Modulus of elasticity		1,600,000 lbs. sq. in.		

TABLE II

GENERAL STRUCTURAL GRADES.

(Graded for Density)

	CLASS A	CLASS B	CLASS C	CLASS D
Bending, extreme fibre	1100	1400	1600	2000
Direct tension (net area)	1100	1400	1600	2000
Compression (short columns)	900	1100	1200	1600
Compression (long columns)	Reduce direct compression by product of C/75x1/d.***			
Compression (flatwise)	250	300	350	500
Longitudinal shear (uniform load)	100	125	150	275
Longitudinal shear (concentrations)**	150	175	200	275
Shear with grain (details)	150	150	150	275
Design Weight per cubic foot	48 Lbs.	48 Lbs.	42 Lbs.	48 Lbs.
Modulus of elasticity		1,600,000 lbs. sq. in.		

*A. S. T. M. Specifications for Density.

**Concentration within two beam depths of end support.

***C—Value for Compression (short columns).

Recommended Fibre Stresses

(Lbs. per sq. in.)

TABLE III

GENERAL STRUCTURAL GRADES.

(Not graded for density)

	CLASS A	CLASS B	CLASS C	CLASS D
Bending, extreme fibre	900	1100	1200	1800
Direct tension (net area)	900	1100	1200	1800
Compression (short columns)	800	900	1000	1400
Compression (long columns)	Reduce direct compression by product of C/75x1/d.***			
Compression (flatwise)	250	300	350	500
Longitudinal shear (uniform load)	100	110	125	200
Shear with grain (details)	100	110	125	200
Design weight per cubic foot	48 Lbs.	42 Lbs.	36 Lbs.	48 Lbs.
Modulus of elasticity	1,600,000 lbs. sq. in.			

Heavy Joist and Dimension

For house framing with interior plastered ceilings, the depth of floor beams is usually determined by safe limits of deflection. This type of construction occurs largely in residence buildings for which building code requirements exceed the actual live loads that are likely to obtain. Designs based on the following stresses will result in satisfactory construction. The better grade material will be utilized especially in offices, warehouses, store and mercantile buildings of wood joisted construction.

TABLE IV

Selected No. 1 Common Dimension.

Bending, extreme fibre	1800	pounds per square inch
Compression (flatwise)	350	" " " "
Shear with grain	150	" " " "
Modulus of elasticity	1,600,000	" " " "
Design weight per cubic foot	42	" " " "

TABLE V

Common Dimension.

Bending, extreme fibre	1200	pounds per square inch
Compression (flatwise)	350	" " " "
Shear with grain	125	" " " "
Modulus of elasticity	1,600,000	" " " "
Design weight per cubic foot	36	" " " "

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